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Ratings of Overall Olfactory Function

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Abstract

The aim of this study was to investigate the accuracy of self-reported ratings of olfactory function in 83 healthy subjects. Such ratings were compared with quantitative measures of olfactory function, as well as with ratings of nasal patency. In experiment 1 subjects rated olfactory function and nasal patency before olfactory testing, whereas in experiment 2 the reverse was the case. No feedback regarding test results were provided until after completion of the testing. The principal findings were: (i) when ratings preceded measurements of olfactory function, there was no significant correlation between the two parameters. However, ratings of olfactory function correlated significantly with ratings of nasal airway patency. (ii) In contrast, when measurements of olfactory function preceded the ratings, this constellation switched. Now ratings of olfactory function correlated significantly with measured olfactory function, whereas there was no significant correlation between ratings of nasal airway patency and ratings of olfactory function. In conclusion, these data suggest that ratings of olfactory function are unreliable in healthy, untrained subjects. The ratings seem to reflect changes of nasal airway patency to a larger degree than measurable olfactory function. The results further indicate that this is mainly due to the limited attention the sense of smell receives in daily life.

Key words: nasal airflow sensation, self-rating, smell

Introduction

Patients with chronic rhinosinusitis seem to be able to correctly rate their olfactory function (Klimek *et al.*, 1998). However, older people and patients with Alzheimer's disease are commonly unaware of their olfactory deficits (Nordin *et al.*, 1995; Murphy *et al.*, 2002). Despite these conflicting data, the relationship between ratings of olfactory function and measured olfactory sensitivity has not been explored systematically. Thus, the aim of the present study was to investigate how ratings of olfactory function compare with measured olfactory function in healthy, normosmic subjects. Specifically, it explored whether discrepancies between measures and ratings of olfactory function relate to the limited attention the sense of smell receives in daily life (Miwa *et al.*, 2001). It was hypothesized that the correlation between ratings and measures of olfactory function would improve if subjects had an opportunity to focus on their olfactory abilities.

To investigate this hypothesis, two experiments were conducted. In the first experiment, subjects were asked to rate their olfactory function. Following this, olfactory function was measured. In the second experiment, in a different group of subjects, olfactory function was tested before ratings of olfactory sensitivity were obtained. These subjects rated their olfactory function without any feedback about the results of the olfactory tests.

Material and methods

Subjects

Sixty subjects (41 women, 19 men, mean age 32 years) participated in experiment 1. Twenty-three subjects (11 women, 12 men, mean age 26 years) participated in experiment 2. All subjects were naive to olfactory testing. They underwent an ear, nose and throat examination, including nasal endoscopy. Endoscopy was done without using decongestants or topical anaesthetics. Subjects provided informed consent, and the study was conducted according to the Declaration of Helsinki on Biomedical Research Involving Human Subjects.

Subjects of both groups were given ample time to familiarize themselves with the experimental situation. In experiment 1 subjects rated olfactory function and nasal patency first and then received olfactory testing. In experiment 2 this order was reversed. Subjects did not receive any feedback regarding their test results until after they had finished the ratings.

Ratings of olfactory function and nasal airway resistance

Participants were asked to rate their olfactory function as well as the perceived nasal airway resistance using visual analogue scales. For olfactory ratings, the left-hand end of the scale was labelled with 'absent olfactory function' and the right-hand end was labelled with 'excellent olfactory function'. For ratings of nasal airway resistance, the left-hand end of the scale was labelled with 'completely blocked nose' while the right-hand end was labelled with 'absolutely free nose'.

Assessment of olfactory function

Psychophysical testing of olfactory function was performed by means of the 'Sniffin' Sticks' test battery (Kobal *et al.*, 2000). The test is based on the assessment of the olfactory threshold (*n*-butanol), discrimination and identification. Results of the three subtests are presented as a composite 'TDI score', which is the sum of individual scores for threshold, discrimination and identification measures (Kobal *et al.*, 2000).

Measurement of nasal airway resistance

Anterior rhinomanometry (Rhinometer 200; ATMOS, Lenzkirch, Germany) was used for nasal airway resistance recordings (measured in Pa/cm^3/s) (McCaffrey, 1991). Total nasal airway resistance at a pressure of 150 Pa was calculated as the sum from left- and right-sided nasal airway resistance.

Statistical analyses

Results were analysed using SPSS 10.0™ (SPSS Inc., Chicago, IL). Descriptive statistics are presented within the body of the text as means ± SEM. Student's *t*-tests for unpaired samples were employed for comparison between ratings of the two groups. Correlation analyses were performed using Spearman statistics. The alpha level was 0.05.

Results

All subjects had TDI scores indicating normal olfactory function (TDI score = 37.2 ± 0.4, range 31–47 points).

Ratings and measures of olfactory function

There was no significant difference between TDI scores obtained in experiments 1 and 2, with mean TDI scores of 37.1 ± 0.4 and 37.3 ± 0.8 in experiments 1 and 2, respectively. Subjects rated their olfactory function within a range of 38–100% (mean 69 ± 2%). No significant difference in ratings of olfactory function was observed between the two experiments (experiment 1, 70 ± 2%; experiment 2, 69 ± 3%).

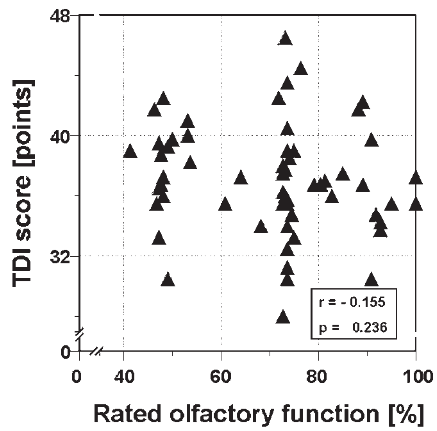

Figure 1. Experiment 1: correlation between self-rated olfactory function and subsequently measured olfactory function (TDI score). In this group there was no significant correlation ($r = -0.155$) between the two parameters ($P = 0.24$). Note the break of axes.

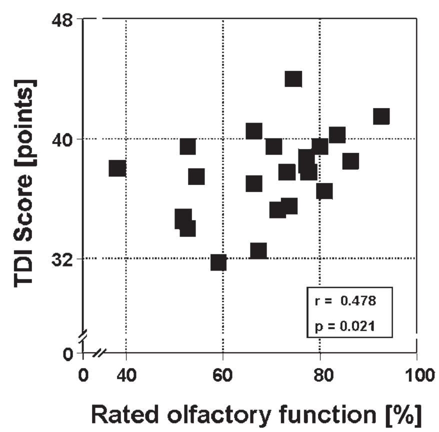

Figure 2. Experiment 2: correlation between measured olfactory function (TDI score) and subsequent ratings of olfactory function. The coefficient of correlation ($r = 0.48$) was significant ($P = 0.021$). Note the break of axes.

In experiment 1 a significant correlation was found between ratings of olfactory function and ratings of nasal patency ($r_{60} = 0.39$, $P = 0.002$). Ratings of olfactory function were not significantly correlated to measured olfactory function ($r_{60} = -0.15$; Figure 1). In contrast, in experiment 2 a significant correlation was found between ratings and measures of olfactory function ($r_{23} = 0.48$, $P = 0.02$; Figure 2), while no significant correlation was observed between ratings of nasal patency and ratings of olfactory function ($r_{23} = 0.35$). Measured nasal airway resistance was not significantly correlated to ratings of olfactory sensitivity or measured olfactory function. Compatible with these results, in experiment 1, median split analysis (comparing ratings above the median to those below the median) revealed no significant group differences for any of the measured parameters. In contrast, for experiment 2 a significant difference was found with regard to TDI scores. Specifically, subjects rating their olfactory function above the median had significantly higher TDI scores than subjects rating their olfactory abilities below the median ($P = 0.02$).

Ratings of nasal airway patency were not significantly different between the two experiments ($P = 0.06$; experiment 1, 71.7 ± 2.4%; experiment 2, 79.6 ± 2.9%). Ratings of nasal airway patency and measured nasal airway resistance exhibited no significant correlation.

Discussion

The principal findings of the present study were: (i) when ratings preceded measurements of olfactory function, there was no significant correlation between the two parameters. However, ratings of olfactory function correlated significantly with ratings of nasal airway patency. (ii) In contrast, when measurements of olfactory function preceded the ratings, this pattern reversed. Ratings of olfactory function correlated significantly with measured olfactory function, whereas there was no significant correlation between ratings of nasal airway patency and ratings of olfactory function.

Young healthy subjects naïve to olfactory tests seem to be unable to judge their olfactory sensitivity. To our knowledge, this issue has never been systemically addressed in this population, although some studies have been performed in elderly healthy subjects (Nordin *et al.*, 1995; Murphy *et al.*, 2002). In general, these studies indicate that elderly subjects exhibit a low accuracy in terms of estimating their olfactory function and thus support the present observations.

Interestingly, in experiment 1 rated olfactory function was significantly correlated with ratings of nasal patency, suggesting a link between these two intranasal sensations. In fact, previous experiments have shown that odor intensity depends on the effort associated with inspiration (Youngentob *et al.*, 1986). The sensation of nasal airflow, on the other hand, is mainly mediated by intranasal trigeminal sensors (Eccles *et al.*, 1988). Consequently, topical anaesthesia of the nasal mucosa causes a sensation of nasal obstruction in most subjects without a corresponding change in nasal airway resistance (Jones *et al.*, 1989). In contrast, administration of menthol enhances the sensation of nasal patency through sensitization of mechanic and thermic sensors, again without measurable changes in nasal airway resistance (Burrow *et al.*, 1983). Anaesthesia of the nasal mucosa has been shown to induce a false impression of altered olfactory function (Welge-Luessen *et al.*, 2003). This relationship between perceived olfactory function and ratings of nasal patency also seems to be corroborated by observations made after surgical corrections of nasal obstructions (Damm *et al.*, 2003). Thus, the present findings confirm that ratings of olfactory function are intimately related to the feeling of nasal patency. This may explain why ratings of olfactory function constitute a poor reflection of measured olfactory function, at least in untrained subjects.

A common finding is that patients are relatively accurate in terms of judging their olfactory impairment when they suffer from sinu-nasal symptoms with decreased nasal patency (Nordin *et al.*, 1995; Klimek *et al.*, 1998). Nordin and colleagues even pointed out that patients with chronic rhinosinusitis tend to over-report smell dysfunction (Nordin *et al.*, 1995). However, patients with olfactory dysfunction due to Alzheimer's disease (Nordin *et al.*, 1995), Parkinson's disease (Muller *et al.*, 2002), diabetes mellitus (Jorgensen and Buch, 1961), laryngectomy (van Dam *et al.*, 1999) or chronic renal failure (Frasnelli *et al.*, 2002) apparently are not aware of their olfactory deficit.

The most salient finding of the present study was that a relation between ratings of olfactory function and measured olfactory sensitivity became significant after subjects underwent a period during which they were forced to focus on their olfactory abilities. Specifically, results of the present study suggest that ratings of olfactory function become more accurate after subjects are allowed to consciously evaluate their sense of smell. One reason for this change in accuracy of olfactory ratings may relate to the general disregard of olfactory function in daily life. An imaginable reason for this lack of conscious awareness of olfactory accuracy may be found in the small portion of olfactory fibres projecting to thalamic structures (Smythies, 1997). The present findings may be interpreted such that, in comparison to olfactory mediated sensations, subjects seem to be more aware of the trigeminal activation (airflow sensation) which comes with every inhalation. Obviously, when asked about their olfactory abilities, untrained subjects have difficulties to separate olfactory input and trigeminal, air-flow induced sensations. In turn, this leads to the correlation between ratings of olfactory function and nasal airflow (see Spence *et al.*, 2001). Thus, it is hypothesized that the relatively short period during which attention was directed towards olfaction was sufficient to furnish more accurate judgements in terms of olfactory function.

In conclusion, the present study indicates that ratings of olfactory function are unreliable in healthy, untrained subjects. They are likely to be strongly influenced through the sensation of nasal airflow.

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